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STUDIES ON THE ROLE OF REGIONAL HETEROTHERMY IN THE ENERGY BALA--ETC(U)
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TECHNICAL REPORT #1

(6)

Studies on the Role of Regional Heterothermy in the Energy Balance of Selected Arctic Mammals.

by

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The major objectives of this one year (August 1, 1976 - July 31, 1977) portion of the study were to obtain a suitable number of arctic marmots, Marmota browerii, pursuant to the establishment of a self sustaining colony, familiarize myself with this animal and to determine the usefulness of artificial marmot dens as over wintering sites.

Unfortunately, only a few marmots were obtained and none could be sent to the University of Maryland for preliminary studies at that location. From the animals that were obtained, it was learned that they will utilize the artificial dens and that they apparently reproduce readily in captivity.

Included below is a description of the methods used pertaining to the objectives of the study and a discussion of the results of this year's findings with a listing of the major conclusions.

METHODS

Animal Procurement: Attempts were made to capture marmots in the Anaktuvuk Pass region of the Brook's Range in Alaska during early August 1976, both by myself and by Eskimo hunters.

Attempts to capture arctic ground squirrels, Citellus parryi, and arctic marmots were undertaken by Mrs. Pat Reynolds, supervisor of the animal colony at the Naval Arctic Research Laboratory, Barrow, Alaska. This effort was during June and July, 1977.

Woodchucks, Marmota monax, were to be made available from my colony at the University of Maryland, with additional animals to be captured if necessary.

Artificial Marmot Dens: Two artificial marmot dens were constructed during August, 1976. They were constructed with plywood and consisted of a "box within a box" with the two boxes separated by 7.5 cm. of insulation (Fig. 1). The outer box is approximately 1.1 m long, 0.9 m wide and 1.0 m deep. The inner box is incompletely subdivided into the nest chamber (61 cm long x 76 cm wide x 66 cm deep) and the fecal chamber (30 cm long x 76 cm wide x 66 cm deep). The den was connected to a wire enclosure (2.4 m x 2.4 m) by means of a tunnel (2.4 m long, 20 cm diameter). Each den was partially filled with straw and much excess straw was placed within the wire enclosure in order that the animals could construct suitable nests. Using thermocouples, several temperatures inside and outside the dens were monitored. Such monitoring was done for at least one hour each day from late August 1976 to late June 1977. During September 1976, four marmots were placed into Den #1 and four ground squirrels into Den #2. Associated with Den #1, thermocouples were placed in the following sites.

1. Nest chamber, projecting in 5 cm, 1/2 way up rear wall.
2. Nest chamber, projecting in 5 cm, 1/2 way up front wall.
3. Nest chamber, projecting in 5 cm, center of roof.
4. Fecal chamber, projecting in 5 cm, 1/2 way up rear wall.
5. Fecal chamber, projecting in 5 cm, center of roof.
6. Entrance tunnel, projecting in 2 cm, 61 cm from den.
7. Entrance tunnel, projecting in 2 cm, 122 cm from den.
8. Outside air, projecting 10 cm out from upper left rear corner of den.
9. Soil, 10 cm below surface at rear of den.

Associated with Den #2, thermocouples were placed in the following sites.

1. Nest Chamber, projecting in 5 cm, center of roof.
2. Fecal chamber, projecting in 5 cm, center of roof.
3. Outside air, projecting 10 cm out from upper left rear corner of den.

Equipment Modification: Two Honeywell, Model 15 indicating and recording potentiometers were reconditioned for use with Type T thermocouples.

RESULTS AND DISCUSSION

Animal Procurement: My attempt to capture marmots at Anaktuvuk Pass during August 1976 was unsuccessful. The Eskimo guide at Anaktuvuk Pass was called away shortly after our arrival, to help fight a forest fire. No other hunters in the village seemed interested in assisting us for anything like the agreed upon rate of $100 per animal. Four marmots were captured later in the month by hunters near Anaktuvuk Pass. These were the only marmots obtained during 1976. The four animals were placed into Den #1. Sometime during the Spring breeding occurred and seven young were noted in addition to the four adults in May. The seven young marmots were separated from the adults on July 13. They were being kept in the large wire cage attached to Den #1. The entrance to Den #1 has been sealed and the animals have been provided with a small wooden box (68 cm x 46 cm x 51 cm) which now serves as their den. They seem to be getting along well together. They are weighed at weekly intervals, beginning on July 13. As can be noted in Table 1, each young animal lost weight between the first and second weighings. This is most likely a reflection of the stress induced by being isolated from their parents at the first weighing and no longer able to utilize Den #1, but rather a much smaller nest box. By the third weighing, all had shown a much improved weight gain. In July 1977, another adult marmot was obtained from the Anaktuvuk Pass region. As of August 1, 1977, there are 12 arctic marmots in the NARL colony. Attempts are being made to obtain additional marmots.

As of August 1, 1977, approximately 25 arctic ground squirrels have been captured. Additional ground squirrels will be collected if further attempts to capture marmots prove unsuccessful.

On July 21, 1977, 19 woodchucks arrived at NARL from the colony at the University of Maryland. They arrived in good condition and, after an initial period of quarantine, were placed into a holding room in building #448.

Artifical Marmot Dens: Thermal information pertaining to Dens #1 and #2 are presented in figures 2 - 5. Data points are, with few exceptions, at weekly intervals from August 27, 1976 to June 24, 1977.

Den #2: Figure 2 pertains to Den #2 which contained four ground squirrels. It can be seen that the nest chamber and the fecal chamber temperatures were very close throughout the period of observation. Both chamber temperatures moved in relation to the outside air temperature, although they remained warmer than outside air for most of the period. From October 1 through May 20 the chamber temperatures were below $0^{o}C$ with a low point of $-27^{o}C$ reached on March 18. Chamber temperatures were below $-25^{o}C$ only once. This den had no artificial heat source and presumably the ground squirrels hibernated as they all survived the winter. It would therefore appear that the construction of the Den is such that internal temperatures are not likely to go below $-25^{o}C$ for significant periods.

Den #1: Figures 3, 4, and 5 pertain to Den #1 which contained four arctic marmots. As can be seen in Figure 3, the three nest chamber temperatures (rear, front and roof) declined more or less steadily from September 24 through November 8, reaching at least $-7^{o}C$. I returned to NARL (Nov. 14-18) to examine the dens and noting this rapid decline in nest chamber temperature was fearful that such temperatures might go well

below -20° for extended periods as the ambient declined. Since it would not be practical to examine the animals on a daily basis and I did not want to risk them unnecessarily, an artificial heat source was added to Den #1 on November 16. In one other study[1] with this animal, they survived den temperatures of -25°C. In view of this, a heat source consisting of a 19 l can of water containing a heating element was placed into the nest chamber. As can be seen in Figures 3-5, the nest chamber temperature never went below -13°C. Figure 3 also shows within the nest chamber a maximum thermal separation of 11°C with the roof temperature being the highest. This is to be expected as the heating element was closer to the roof thermocouple than to the others and also the warmer air rises and should therefore be nearer the roof thermocouple. Nest chamber temperatures remained rather steady from December 3 through April 29. Outside air temperatures declined erratically from September 29 and then began a steady rise on March 11. Soil temperature began a gradual decline on September 2 and began a steady rise on April 15. As can be seen on Figures 3,4 the temperature of the rear of the nest and fecal chambers are very similar. This is reasonable as the opening between the two chambers is at the rear. The entrance tunnel of Den #1 contained two thermocouples and, as can be seen in Fugure 4, there was little variation in temperature within the half of the tunnel near the den.

It would therefore appear that these dens are adequate for the year around use by marmots. There is apparently no need for an artifical heat source.

On July 13, Den #1 was opened and the adult marmots moved to another outdoor wire cage. The seven young were confined to their outside wire cage. It was found that the marmots had chewed through the plywood of the inner box at its junction with the entrance tunnel. This allowed them

to enter the insulation space between the inner and outer boxes. Exactly when this occurred is not known. Such chewing was probably a recent occurrence as if it were of long duration, I would have expected them to chew through the wall of the outer box and escape. For subsequent use the interior of the inner box will be lined with wire mesh to prevent such action.

Equipment modification: A Honeywell Model 15 potentiometer had been modified for use during this portion of the study as well as during the remainder of the study. A second instrument has been modified for use for the remainder of the study (after August 1, 1977).

CONCLUSIONS

1. Arctic marmots are very difficult to obtain.
2. Insulated dens constructed of plywood seem suitable for use as over wintering dens.
3. Breeding with subsequent birth of young seems a reasonable expectation from a group of four adult animals of mixed sexes.
4. Such dens should be lined with suitable wire mesh to prevent animals from chewing through plywood.
5. An artifical heat source in the den is not necessary.
6. Using such dens connected to outside wire cages, the establishment of a self sustaining arctic marmot colony seems quite feasible.

REFERENCES

1. Williams, D.D. and Rausch, R.L.,(1973). Seasonal carbondioxide and oxygen concentrations in the dens of hibernating mammals (Sciuridae). Comp. Biochem. Physiol. 44, 1227-1235.

Table 1

Body weight (grams) of arctic marmots born during Spring 1977
at the Naval Arctic Research Laboratory

Animal number	Sex	Body weight		
		July 13, 1977	July 20, 1977	July 27, 1977
5418	M	737	709	879
5419	M	850	737	1021
5433	M	624	567	709
5431	M	737	709	964
5430	F	737	680	822
5426	F	680	595	765
5428	F	794	737	936

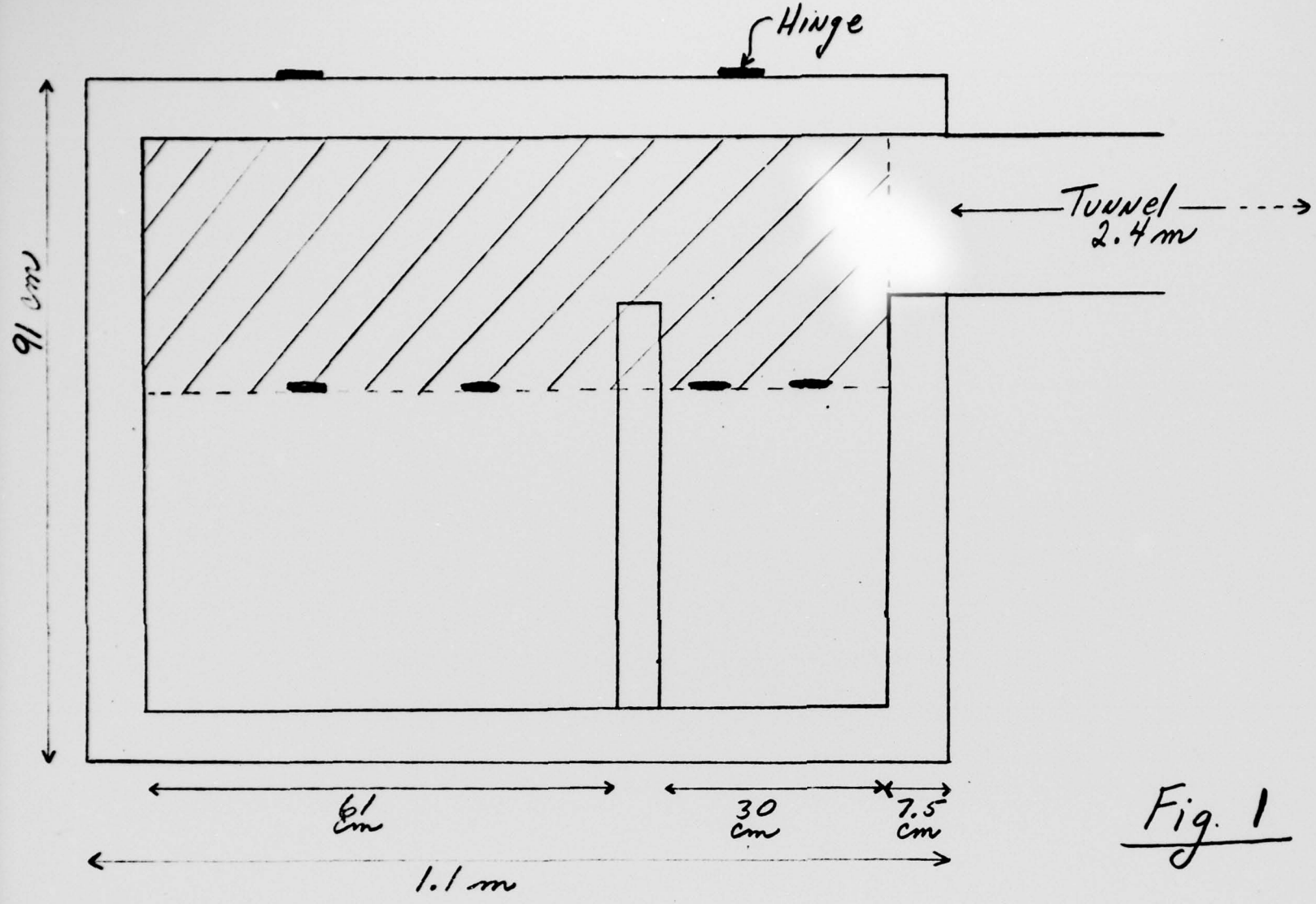

Fig. 1

ARTIFICIAL MARMOT DEN

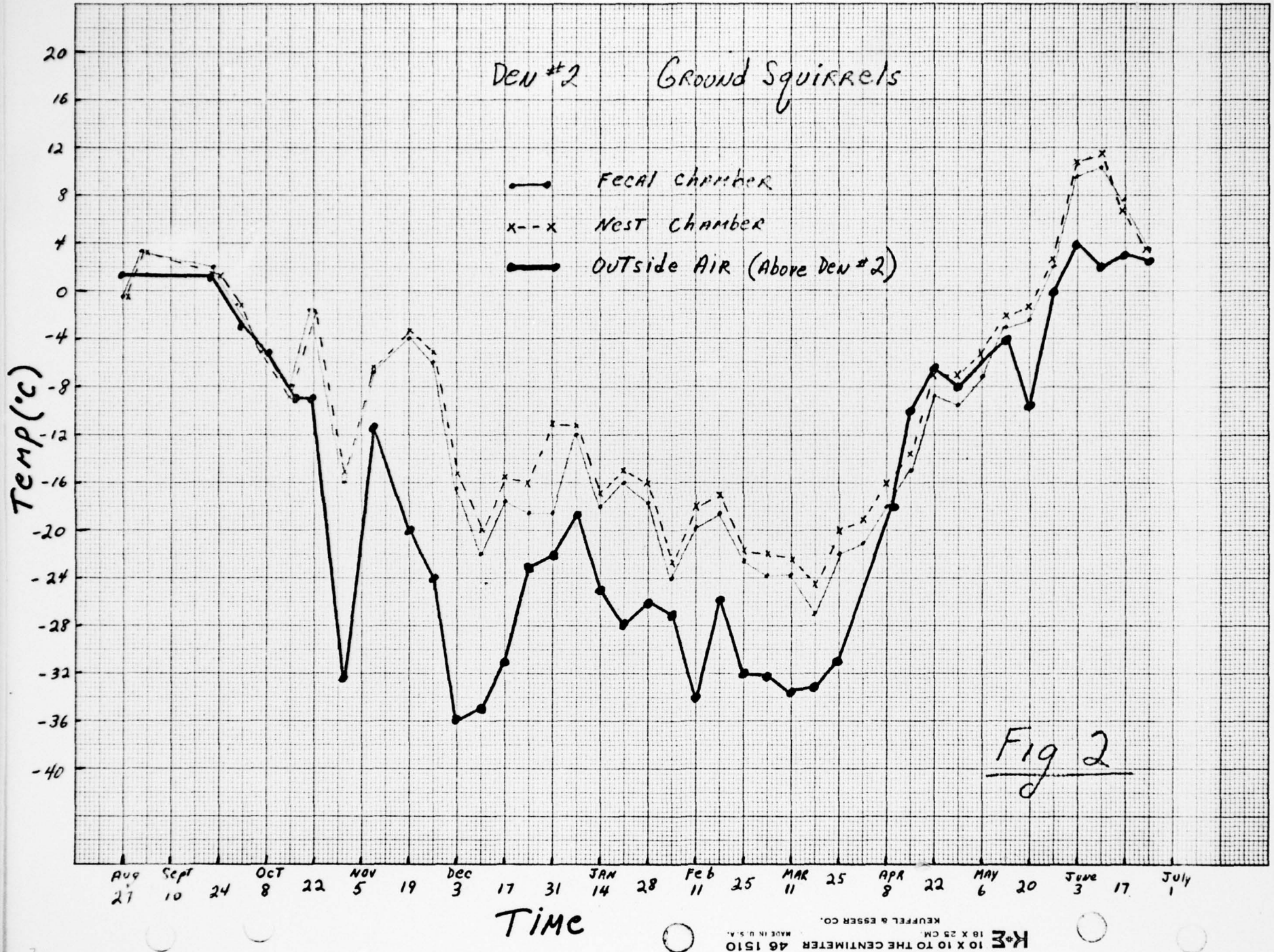

Fig 2

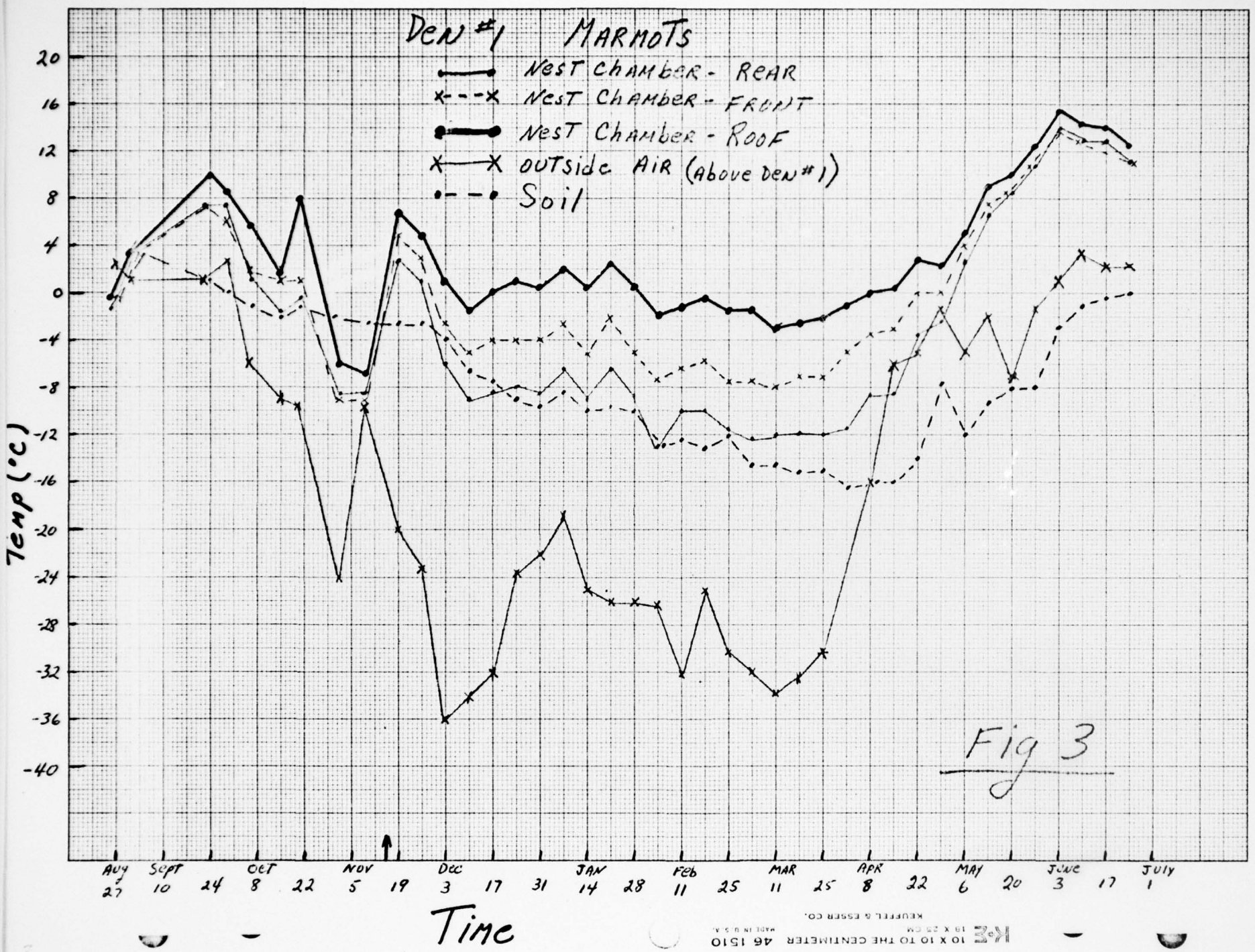
Den #1 Marmots
Nest Chamber - Rear
Nest Chamber - Front
Nest Chamber - Roof
Outside Air (Above Den #1)
Soil
Temp (°C)
20
16
12
8
4
0
-4
-8
-12
-16
-20
-24
-28
-32
-36
-40
Aug 27
Sept 10
24
Oct 8
22
Nov 5
19
Dec 3
17
31
Jan 14
28
Feb 11
25
Mar 11
25
Apr 8
22
May 6
20
June 3
17
July 1
Time

Fig 3

Fig 1

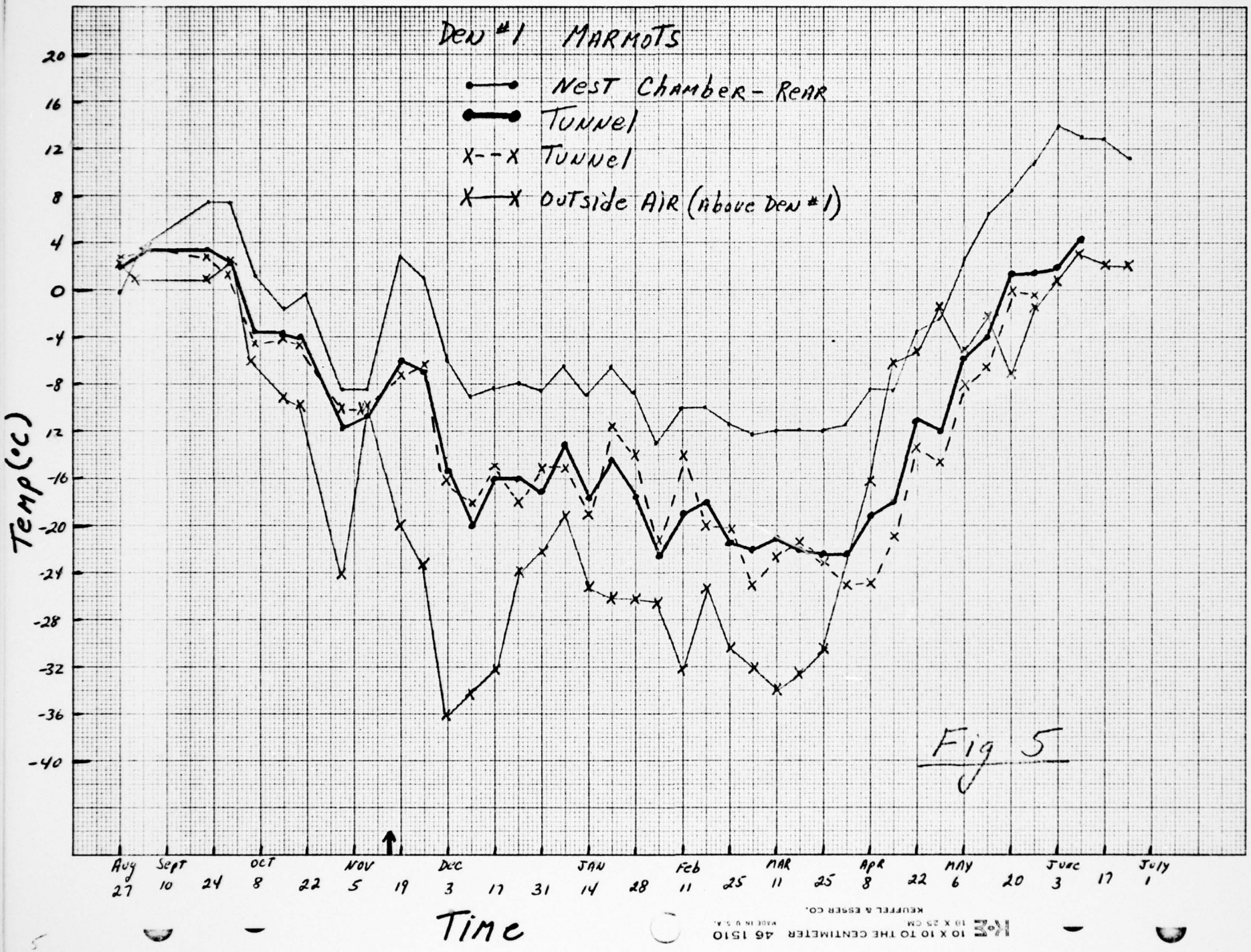

Fig 5

KEUFFEL & ESSER CO.
10 X 10 TO THE CENTIMETER 46 1510
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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

A small colony of arctic marmots, Marmota broweri, has been established at the Naval Arctic Research Laboratory, Barrow, Alaska. Five were trapped in the Alaskan Brook's Range. The other seven were conceived and born in captivity. Artificial marmot dens constructed from plywood contained an insulated nest chamber 61 cm long, 76 cm wide and 66 cm deep. A wooden tunnel connected the den to an external wire enclosure (2.4 m x 2.4 m). Den temperatures were monitored weekly by means of implanted thermocouples.

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20. ABSTRACT (Continued)

Four adults overwintered in a den provided with a modest artificial heat source, in order that they be not unduly risked. Four arctic ground squirrels, Citellus parryi, overwintered in a second den that had no artificial heat source. Their den temperature was only once below -25°C while that of the ambient was below this on 17 occasions. An earlier study (Williams and Rausch, 1973, Comp. Biochem. Physiol. 44, 1227-1235) showed that marmots could overwinter with artificial den temperatures as low as -25°C. In view of this and the finding with the den containing the ground squirrels, it seems that such dens are suitable overwintering sites for marmots in the Barrow area and that the establishment of a self-sustaining colony is likely.

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